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**Name of Organization:** Minnesota Pollution Control Agency

**Type of Organization:** State

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Environmental Outcomes

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**Project Title:** Polybrominated Diphenyl Ethers - A Great Lakes Contaminant

**Project Category:** Pollution Prevention and Reduction - BNS

**Rank by Organization (if applicable):** 2

**Total Funding Requested (\$):** 320,000 **Project Duration:** 2 Years

**Abstract:**

The Minnesota Pollution Control Agency (MPCA) proposes to make quantitative assessments of the prevalence, transport, and fate of Polybrominated Diphenyl Ethers (BDEs) in a selected aquatic and terrestrial ecosystems (i.e., Lake Superior environment). These chemicals have been assessed with regard to intrinsic toxicity, chemical stability, potential to form dibenzo-dioxins and dibenzo-furans under incineration, and also fat-solubility, and hence bioaccumulative properties.

We will examine historical trends in BDEs inputs by collecting and analyzing sediment and soil cores from the selected sites. We will collect air and water samples to look for evidence of atmospheric transport, and we will compare any such transport to surface water inputs to find dominant sources. By analyzing air and biota samples we will look for evidence of a regional source of BDEs. We will collect and analyze aquatic and terrestrial plants and animals to create a database of aquatic and terrestrial BDEs concentrations and use this data to examine bioaccumulation and biomagnification.

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**Geographic Areas Affected by the Project****States:**

|   |  |
|---|--|
| <input checked="" type="checkbox"/> Illinois  | <input checked="" type="checkbox"/> New York     |
| <input checked="" type="checkbox"/> Indiana   | <input checked="" type="checkbox"/> Pennsylvania |
| <input checked="" type="checkbox"/> Michigan  | <input checked="" type="checkbox"/> Wisconsin    |
| <input checked="" type="checkbox"/> Minnesota | <input checked="" type="checkbox"/> Ohio         |

**Lakes:**

|  |   |
|--|---|
| <input checked="" type="checkbox"/> Superior | <input checked="" type="checkbox"/> Erie      |
| <input checked="" type="checkbox"/> Huron    | <input checked="" type="checkbox"/> Ontario   |
| <input checked="" type="checkbox"/> Michigan | <input checked="" type="checkbox"/> All Lakes |

**Geographic Initiatives:**

|  |                                  |                                     |                                      |   |
|--|----------------------------------|-------------------------------------|--------------------------------------|---|
| <input type="checkbox"/> Greater Chicago | <input type="checkbox"/> NE Ohio | <input type="checkbox"/> NW Indiana | <input type="checkbox"/> SE Michigan | <input type="checkbox"/> Lake St. Clair |
|--|----------------------------------|-------------------------------------|--------------------------------------|---|

**Primary Affected Area of Concern:** All AOCs**Other Affected Areas of Concern:**

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***For Habitat Projects Only:*****Primary Affected Biodiversity Investment Area:** All BIAs**Other Affected Biodiversity Investment Areas:**

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**Problem Statement:**

As with many aspects of the modern, technological world, Polybrominated Diphenyl Ethers (BDEs) perform an important, but hidden, function. These chemicals are added to many common items such as plastics, paints, textiles, machines and electronic devices to reduce flammability, and many thousand tons are produced annually. In recent years, however, an unexpected and undesirable consequence of widespread use of BDEs has been observed. Polybrominated Diphenyl Ethers are semi-volatile compounds that resist chemical and biological degradation, and they are lipophilic. An increasing body of evidence suggests that these compounds bioaccumulate and induce undesirable biological outcomes. They are used in large quantities in applications that allow their release into the environment, and they continue to be produced. Given this, it is not surprising that BDEs have been detected throughout the environment in both biotic and abiotic matrices. It has been suggested that BDEs, like PCBs, have become ubiquitous environmental contaminants. European scientists have measured BDEs in several environmental compartments. However, assessment of the occurrence of BDEs in the Great Lakes region is almost non-existent. We propose to build on this data to determine the prevalence, transport, and fate of BDEs in the Great Lakes Region. The relevant characteristics of BDEs may be hypothesized from their 3-D structures, potential chemical reactivities, and physicochemical parameters. Polybrominated diphenyl ethers are chemically similar to polychlorinated biphenyls (PCBs) and dibenzodioxins. Like these compounds, BDEs bioaccumulate when introduced into aquatic or terrestrial ecosystems. Unlike PCBs and Dioxins, BDEs are manufactured and used in increasing quantities. In light of the fact that bioaccumulating compounds must be controlled under various EPA programs, such as the Great Lakes Water Quality Agreement with Canada, the Binational Virtual Elimination Strategy, air toxics, Lakewide Management Plans, Areas of Concern, contaminated sediments and the EPA's Great Lakes Enforcement Strategy will find this research useful, a more thorough understanding of BDEs in the Great Lakes Region is needed.

**Proposed Work Outcome:**

Proposed Work/Outcome:

The MPCA proposes to make quantitative assessments of Polybrominated Diphenyl Ethers (BDEs) in the Lake Superior environment. This will include direct measurements of BDEs in sediment, soil, water, air, aquatic and terrestrial biota. We will use these measurements to create a database of BDE concentrations in and around Lake Superior. The database values will be used as input for models designed to predict the transport and fate of BDEs in the Great Lakes environment. The major components of this project are as follows.

Sample Collection

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**Soil Samples:**

Soil and sediment sampling will help us to establish the history of inputs of BDEs to Lake Superior environment, and whether rates of input are increasing or decreasing, by creating soil and sediment depth profiles of BDEs. The choice of location for the collection of sediment and soil samples provides an ideal example of the type of collaboration that is possible within the proposed project. Although we have no information on BDEs in sediment or nearby soil of Lake Superior environment, it is anticipated that our proposed project will create six to seven sediments and six to seven soil depth profiles, representing quarterly sample collection.

**Water Samples:**

To determine the dominant methods of transport of BDEs to Lake superior, we will collect water samples (dissolved and particulate samples), and compare levels of BDEs in lake water with levels in the air. We anticipate collecting quarterly samples, about six to seven water samples (6-7 dissolved and 6-7 particulate samples) over the course of the project.

**Air Samples:**

To look for evidence of atmospheric transport and deposition, we will collect air samples and we will compare any such transport to surface water inputs to find dominant sources. We will use high-volume air sampling techniques to collect representative air samples from the Lake Superior environment. Our sampling methodology will collect both phases. We anticipate collecting quarterly samples of 6-7 vapor and 6-7 particulate samples over the course of the project.

**Biological Samples:**

We will collect and analyze aquatic and terrestrial plants and animals to create a database of aquatic and terrestrial BDEs concentrations and use this data to examine bioaccumulation and biomagnification.

One set of Phytoplankton, zooplankton, and benthic invertebrates at each sediment sampling station will be collected. We also plan to collect one set of earthworm and representative terrestrial vegetation at each soil sampling station. We anticipate gathering both forage and predator species of fish during each sediment sampling cruise. We will obtain these samples from commercial fishers. The fish will have been caught during the time of the sediment sampling cruises and from approximately the same area of the lake.

The results of this study will provide vital information for the international efforts to virtually eliminate toxic substances from the Great Lakes regions. While large amounts of study have been directed at pollution of the Great Lakes by chlorinated compounds such as dioxins and PCBs, virtually no data have been collected on brominated compounds. Yet, as explained, brominated compounds are widely used, in many cases for the same purposes as the chlorinated compounds.

This study will provide some unique non-PCB type data, data that in hindsight should have been obtained before. If cost-effective clean-up decisions are to be made concerning refractory pollutants, PDEs need to be considered as part of an overall strategy. Are BDEs in the sediment at high enough concentrations to warrant removal? Will BDEs continue to be produced and lost to the environment so that they simply replace the pollutants we remove through costly clean-up programs? These and other questions can not be ignored from a management perspective.

The information will benefit the U.S./Canadian International Joint Commission (IJC), which has as one of its primary responsibilities preserving or enhancing the quality of the Great Lakes environment. Many of the committees of the IJC, such as the Council of Research Managers, continue to focus on toxic substances as a critical concern and are continually looking to identify new substances that may be causing pollution. Compounds that bioaccumulate, like the BDEs, are especially critical given all that was learned from PCBs. The U.S. Environmental Protection Agency (EPA) will also obviously benefit from this project, given their role in reducing toxic pollution and their interest in the Great Lakes. Various priorities of the EPA, such as the Great Lakes Water Quality Agreement with Canada, the Binational Virtual Elimination Strategy, air toxics, Lakewide Management Plans, Areas of Concern, contaminated sediments and the EPA's Great Lakes Enforcement Strategy will find this research useful.

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**Project Milestones:****Dates:**

|   |         |
|---|---------|
| Sampling/analyses                       | 10/2000 |
| Sampling/analyses                       | 02/2001 |
| Sampling/analyses                       | 04/2001 |
| Sampling/analyses                       | 09/2001 |
| Sampling/analyses                       | 02/2002 |
| Sampling/analyses                       | 07/2002 |
| Data analysis and report generation     | 08/2002 |
| Enter data into Storet and USGS systems | 09/2002 |

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☐ Project Addresses Environmental Justice

**If So, Description of How:**

☒ Project Addresses Education/Outreach

**If So, Description of How:**

The result of this project will be used to develop an educational package on flame-retardants and their environmental effects. Training workshops will be offered to stakeholders and MPCA staff. CD-based ArcView projects of the database will be developed. This study will be one of the first report providing information on PDEs as a highly toxic, persistent, and bioaccumulative chemical (PBTs). Local high schools, colleges and universities will be able to incorporate this educational package and the easy to use database into their environmental science program. Outreach will be done to let Minnesota's citizens learn more about their environment. Main product of this research will be conference presentations and several professional papers in high quality scientific journals.

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**Project Budget:**

|                            | <b>Federal Share Requested (\$)</b> | <b>Applicant's Share (\$)</b> |
|----------------------------|-------------------------------------|-------------------------------|
| <b>Personnel:</b>          | 30,000                              | 5,000                         |
| <b>Fringe:</b>             | 6,300                               | 1,050                         |
| <b>Travel:</b>             | 5,000                               | 1,000                         |
| <b>Equipment:</b>          | 28,000                              | 0                             |
| <b>Supplies:</b>           | 15,000                              | 4,357                         |
| <b>Contracts:</b>          | 219,524                             | 0                             |
| <b>Construction:</b>       | 0                                   | 0                             |
| <b>Other:</b>              | 5,000                               | 5,000                         |
| <b>Total Direct Costs:</b> | 308,824                             | 16,407                        |
| <b>Indirect Costs:</b>     | 11,176                              | 593                           |
| <b>Total:</b>              | 320,000                             | 17,000                        |
| <b>Projected Income:</b>   | 0                                   | 0                             |

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**Funding by Other Organizations (Names, Amounts, Description of Commitments):**

Five percent of the entire project costs will be provided in cash, or by in-kind contributions and other non-cash support, from the MPCA. In the above budget, Dr. W.C. Sonzogni will perform approximately \$35,000 of contractual work.

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**Description of Collaboration/Community Based Support:**

Although no other direct support other than GLNPO is anticipated, the study will greatly profit (only possible) through the help of the nationally recognized pioneered scientists in this field from Sweden (Professor Ake Bergman, Chair of Environmental Chemistry, Stocklom University) and Canada (Professor Mehran Alaei, Environment Canada).

Community-based support will be obtained from grass roots community groups dealing with Persistent Bioaccumulative Toxic Chemicals (PBTs), and may also be obtained through the technical transfer of information about the database at local environmental fairs.